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(64) **Chewable spray dried spheroidal microcapsules and polymer coated microcapsules and method for preparing same.**

(67) The present invention pertains to a spray dried spheroidal microcapsule under about 150 microns in diameter which comprises (a) a medicament present in an amount from about 1% to about 90%, by weight of the microcapsule composition, (b) a film forming polymer present in an amount from about 8% to about 90%, by weight of the microcapsule composition, and (c) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer. In another embodiment, the invention is directed at a spheroidal coated microcapsule under about 850 microns in diameter which comprises at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, wherein the coating layer comprises (a) a film forming polymer, and (b) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer.

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CHEWABLE SPRAY DRIED SPHEROIDAL MICROCAPSULES AND POLYMER COATED MICROCAPSULES AND METHODS FOR PREPARING SAME

- This invention pertains to novel chewable spray dried spheroidal microcapsule and coated microcapsule compositions. The novel microcapsule compositions comprise a medicament, a film forming polymer, and a plasticizing agent. The microcapsules may be coated with a film forming polymer to prepare chewable spheroidal coated microcapsules. Therapeutically effective amounts of the spray dried spheroidal microcapsules and spheroidal coated microcapsules may be utilized in a wide variety of pharmaceutically acceptable carriers and confectionery bulking agents to prepare medicated products and sustained release medicated compositions. This invention also relates to methods for preparing these chewable spray dried spheroidal microcapsules and spheroidal coated microcapsules and the medicated products and the sustained release medicated compositions in which they may be used.
- Sustained release compositions for the sequential or timed release of medicaments are well known in the art. Generally such compositions contain medicament particles, normally administered in divided doses two or more times daily, mixed with or covered by a coating material which is resistant to degradation or disintegration in the stomach and/or in the intestine for a selected period of time. Release of the medicament may occur by leaching, erosion, rupture, diffusion or similar actions, depending upon such factors as the nature and thickness of the coating material.
- Sustained release formulations initially utilized solvent-based film coatings. Because of cost and environmental and safety (toxicity) concerns with the solvents, colloidal (latex) and near colloidal (pseudolatex) aqueous dispersion coatings were developed to replace solvent-based film coatings.
- Latex dispersions, such as those disclosed in United States patent no. 3,608,063, issued to Banker, and United States patent no. Re. 28,316, also issued to Banker et al. and assigned to Purdue Research Foundation, are made from a synthetic polymer with a liquid monomer and are prepared by emulsion polymerization. Pseudolatex dispersions can be prepared from any thermoplastic, water-insoluble polymer. Preferred pseudolatex polymers for use in many pharmaceutical applications are the derivatives of cellulose.
- A frequently encountered problem in the field of chewable sustained release compositions is unsuitable particle size and shape. Particle sizes larger than about 850 microns are usually considered unsatisfactory for chewing because these particles are gritty and are easily broken during chewing thereby causing an off-taste and premature release of the medicament in the mouth. Spheroidal sustained release particles are generally preferred over non-spheroidal particles because these uniformly coated materials protect the medicament from premature release and release the medicament more uniformly.
- Small sustained release particles, or microcapsules, suitable for use in chewing compositions are generally easier to prepare with a solvent-based film coating because of the high volatility and low surface tension of the solvent. For the reasons set out above, sustained release microcapsules prepared from aqueous-based coating materials are usually preferred, however, these microcapsules are generally larger in size than those obtained from solvent-based coating materials and must be ground to obtain smaller chewable microcapsules. These ground smaller particles are usually not satisfactory for use in sustained release compositions because the particles are irregular, are not spheroidal and do not release the medicament uniformly.
- United States patent no. 4,749,575, issued to Rotman and assigned to Bio-Dar Ltd., discloses the preparation of chewable microcapsules of less than 300 microns diameter formed by dissolving a polymer such as hydroxypropyl methylcellulose phthalate, hydroxyphenyl methylcellulose or various acrylic resins in an organic solvent and coating a medicament with the polymer solution in a fluidized bed.
- European patent application no. 266,113 discloses a method for preparing a taste masked therapeutic composition which comprises spray drying a suspension of acetaminophen in a solution of an acrylic polymer in an organic solvent.
- European patent application no. 250,648 and Goodman et al., Journal of Pharmaceutical Sciences, 59, 1131-1137 (1970), disclose methods for preparing microspheres suitable for formulating into a tablet which comprise slurrying an aqueous mixture of a drug and an acrylic polymer, vacuum drying the mixture, then grinding the so-formed particles, and compressing the particles into a tablet.
- PCT application no. PCT/U.S.87/03068 discloses a method for preparing a taste-masked pharmaceutical composition which comprises spraying in a fluidized bed a suspension comprised of a mixture of an aqueous based solution of a high temperature film forming polymer and a low temperature film forming polymer onto particles of a pharmaceutical core material. The high temperature film forming polymer can be ethyl cellulose or an acrylic polymer and the low temperature film forming polymer can be an acrylic

polymer.

European patent application no. 285,226 discloses a method for preparing a taste masked therapeutic composition which comprises spray drying a suspension of colloidal silica in an alcoholic solution of acetaminophen and ethyl cellulose.

- 6 United States patent no. 4,784,380, issued to Urquhart et al. and assigned to Alza Corporation, discloses a drug delivery system for microcapsules which can be prepared from an aqueous mixture of the drug and ethyl cellulose. The mixture is blended and kneaded, then extruded and passed through a 20 mesh screen. The microcapsules may be coated over with ethyl cellulose by air suspension.

- While the above sustained release compositions provide some degree of improved chewable sustained
10 release activity, none of the above compositions are entirely satisfactory. Chewable sustained release compositions prepared from organic solvent based polymer solutions are expensive and pose environmental and toxicity problems. Chewable sustained release compositions prepared from aqueous dispersions of polymers generally provide large microcapsules which must be ground to smaller particles which are usually not uniform in size, shape and composition. Thus it would be advantageous to prepare a sustained
15 release composition from an aqueous dispersion of polymer whereby the microcapsules formed are spheroidal and are of sufficiently small size such that they are not gritty and can be chewed without being broken. The present invention provides such improved chewable spheroidal microcapsules and spheroidal coated microcapsules without the disadvantages characteristic of previously known products. The present invention also provides methods for preparing these improved spheroidal microcapsules and coated
20 microcapsules and the medicated products and sustained release compositions in which they may be employed.

- The present invention pertains to spray dried spheroidal microcapsules under about 150 microns in diameter which comprise (a) a medicament present in an amount from about 1% to about 90%, by weight of the microcapsule composition, (b) a film forming polymer present in an amount from about 8% to about
25 90%, by weight of the microcapsule composition, and (c) a plasticizing agent in an amount from about 5% to about 30%, by weight of the film forming polymer. In another embodiment, the invention is directed at a spheroidal coated microcapsule under about 850 microns in diameter which comprises at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, wherein the coating layer comprises (a) a film forming polymer, and (b) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer. The microcapsule and coated
30 microcapsule compositions may be utilized in a wide variety of pharmaceutically acceptable carriers and confectionery bulking agents to prepare medicated products and sustained release compositions. This invention also relates to methods for preparing these microcapsules and the medicated products and sustained release compositions in which they may be employed.

- 35 FIGURE 1 is a picture of spray dried spheroidal microcapsules of pseudoephedrine sulfate and ethyl cellulose. The spheroidal appearance is clearly seen.

FIGURE 2 depicts spray dried spheroidal microcapsules enlarged 400 times of pseudoephedrine sulfate and ethyl cellulose (magnification 400X). The spheroidal appearance is clearly seen.

- FIGURE 3 depicts coated spheroidal microcapsules of pseudoephedrine sulfate and ethyl cellulose (left
40 half, magnification 50X, right half, magnification 3000X). The spheroidal appearance is clearly seen.

- The present invention pertains to improved chewable medicated products and sustained release compositions for administering a medicament, normally administered in divided doses two or more times daily. More specifically, the present invention pertains to spray dried spheroidal microcapsules under about 150 microns in diameter which comprise (a) a medicament present in an amount from about 1% to about
45 90%, by weight of the microcapsule composition, (b) a film forming polymer present in an amount from about 8% to about 90%, by weight of the microcapsule composition, and (c) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer.

- In another embodiment, the invention is directed at spheroidal coated microcapsules under about 850 microns in diameter which comprise at least one spray dried spheroidal microcapsule core under about 150
50 microns in diameter and a coating layer over the core, wherein the coated microcapsules comprise (A) a microcapsule core comprising (a) a medicament present in an amount from about 1% to about 90%, in percentages by weight of the core composition, (b) a film forming polymer present in an amount from about 8% to about 90%, in percentages by weight of the core composition, and (c) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer, and (B) a coating layer
55 over the core comprising (a) a film forming polymer, and (b) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer.

The microcapsule and coated microcapsule compositions may be utilized in a wide variety of pharmaceutically acceptable carriers and confectionery bulking agents to prepare medicated products and

sustained release compositions. This invention also relates to methods for preparing these microcapsules and coated microcapsules and the medicated products and sustained release compositions in which they may be employed.

- While the invention is not to be limited to theoretical considerations, applicant believes that by carefully controlling the concentration of a medicament and a film forming polymer in an aqueous suspension, and carefully controlling the conditions of spray drying the suspension, spheroidal microcapsules of sufficiently small particle size suitable for use in chewable medicated compositions can be prepared. By forming the microcapsules by spray drying, applicant's microcapsules are spheroidal and release the medicament more uniformly than prior art compositions. Moreover because applicant's microcapsule compositions are prepared from aqueous slurries, the resulting compositions are more economical to prepare and do not have the potential toxicity and environmental problems which can accompany the preparation of such compositions from organic solutions. Furthermore by carefully controlling the conditions for spray coating the spheroidal microcapsules, spheroidal coated microcapsules or spheroidal coated agglomerates of microcapsules, which contain a plurality of microcapsules in a single coating, can also be prepared suitable for use in chewable sustained release medicated compositions.

- In a preferred embodiment, the spray dried spheroidal microcapsules comprise in percentages by weight of the microcapsule composition (a) a medicament present in an amount from about 1% to about 90%, (b) a film forming polymer present in an amount from about 8% to about 90%, and (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule. In a more preferred embodiment, the spray dried spheroidal microcapsules comprise in percentages by weight of the microcapsule composition (a) a medicament present in an amount from about 1% to about 70%, (b) a film forming polymer present in an amount from about 20% to about 90%, and (c) a plasticizing agent present in an amount from about 5% to about 24%, in percentages by weight of the film forming polymer in the microcapsule. In a most preferred embodiment, the spray dried spheroidal microcapsules comprise in percentages by weight of the microcapsule composition (a) a medicament present in an amount from about 1% to about 50%, (b) a film forming polymer present in an amount from about 30% to about 90%, and (c) a plasticizing agent present in an amount from about 5% to about 20%, in percentages by weight of the film forming polymer in the microcapsule.

- In an alternative embodiment, the spray dried spheroidal microcapsules may further comprise a dispersing agent present in an amount up to about 12%, preferably in an amount up to about 10%, and more preferably in an amount up to about 7%, by weight of the microcapsule composition.

- The medicaments (drugs, pharmaceuticals) of the present invention may be selected from a wide variety of water-soluble and water-insoluble drugs and their acid addition salts. Both organic and inorganic salts may be used provided the drug maintains its medicament value. Exemplary acid salts include hydrochloride, hydrobromide, orthophosphate, benzoate, maleate, tartrate, succinate, citrate, salicylate, sulfate and acetate.

- The medicament may be selected from a wide range of therapeutic agents and mixtures of therapeutic agents which may be administered in sustained release or prolonged action form. Nonlimiting illustrative categories and specific examples of such medicaments include:

- (a) Analgesics, such as acetylsalicylic acid, acetaminophen, ibuprofen, phenacetin, phenylbutazone, salicylamide, sodium salicylate, and meclofenamic acid;
- (b) Anthelmintics, such as diethazine iodide and gerdone;
- (c) Antiasmatics, such as aminophylline, metaproterenol, epinephrine and theophylline;
- (d) Anticholesterolemic and antilipid agents, such as gemfibrozil;
- (e) Antiemetics, such as prochlorperazine dimaleate;
- (f) Antihistamines, such as chlorpheniramine maleate, brompheniramine maleate, phenindamine tartrate, pyrilamine maleate, methapyrilene fumarate, doxylamine succinate, phenyltoloxamine citrate, diphenhydramine hydrochloride, promethazine, terfenadine and triprolidine;
- (g) Anti-inflammatory agents, such as isoxicam, meclofenamic acid and naproxen;
- (h) Antinauseants, such as dimenhydrinate and meclizine;
- (i) Antipyretics, such as N-acetyl-p-aminophenol;
- (j) Antitussives, such as dextromethorphan, dextromethorphan hydrobromide, noscapine, carbetapentane citrate, chlorhexanol hydrochloride, codeine and diphenhydramine hydrochloride;
- (k) Appetite suppressants, such as phenylpropanolamine hydrochloride and caffeine;
- (l) Cathartics, such as castor oil;
- (m) Central nervous system stimulants, such as nicotine and caffeine;
- (n) Decongestants, such as phenylephrine hydrochloride, phenylpropanolamine hydrochloride, pseudoephedrine hydrochloride, pseudoephedrine hydrobromide, pseudoephedrine sulfate and ephedrine.

drine;

(c) Expectorants, such as guaifenesin and glycerol guaiacolate;

(p) Laxatives, such as phenolphthalein, danthron, pamabrom and bisacodyl;

(q) Nutritional supplements, including vitamins and minerals, such as ascorbic acid, niacin, pantothenic acid, vitamin B6, thiamine hydrochloride, riboflavin, potassium iodide, potassium chloride, cupric sulfate and ferrous sulfate; and

(r) Various alkaloids, such as codeine phosphate, codeine sulfate and morphine.

In a preferred embodiment, the medicament is a water-soluble medicament selected from the group consisting of dextromethorphan, dextromethorphan hydrobromide, pseudoephedrine, pseudoephedrine sulfate, pseudoephedrine hydrochloride, pseudoephedrine hydrobromide, chlorpheniramine maleate, guaifenesin, diphenhydramine hydrochloride, and mixtures thereof. In a more preferred embodiment the medicament is a water-soluble medicament selected from the group consisting of pseudoephedrine sulfate, diphenhydramine hydrochloride, chlorpheniramine maleate, and mixtures thereof.

The medicament of the present invention may be used in many distinct physical forms well known in the pharmaceutical art to provide an initial dosage of the medicament and/or a further time-release form of the medicament. Without being limited thereto, such physical forms include free forms and encapsulated forms, and mixtures thereof.

The amount of medicament drug or its acid addition salt used in the present invention may vary depending upon the therapeutic dosage recommended or permitted for the particular medicament. In general, the amount of medicament present is the ordinary dosage required to obtain the desired result. Such dosages are known to the skilled practitioner in the medical arts and are not a part of the present invention.

The film forming polymers useful in the present invention are aqueous colloidal dispersions containing spherical, solid or semisolid particles less than about one (1) micron in diameter, and typically less than about 0.1 micron in diameter. Aqueous colloidal mixtures are generally very fluid at concentrations from about 20% to about 40%. Suitable film forming polymers in the present invention include cellulose derivatives such as ethylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxypropylmethylcellulose phthalate, methylcellulose, sodium carboxymethylcellulose, and the like, and mixtures thereof. Other suitable film forming polymers in the present invention include aqueous acrylic resin dispersions such as polyacrylamide, polyacryldextran, polyalkyl cyanoacrylate, polymethyl methacrylate, and the like, and mixtures thereof. In a preferred embodiment, the film forming polymer is a cellulose derivative such as ethylcellulose. In a more preferred embodiment, the film forming polymer is the commercially available aqueous polymeric dispersion manufactured under the tradename AQUACOAT (24.5%-30% ethyl cellulose), by FMC Corporation, Princeton, New Jersey. In another more preferred embodiment, the film forming polymer is the commercially available aqueous polymeric dispersion manufactured under the tradename SURELEASE (containing 24.5%-29.5% ethyl cellulose, dibutyl sebacate and oleic acid as plasticizing agents, and fumed silica as an anti-adherent), by Colorcon, Inc., West Point, Pennsylvania.

Plasticizing agents (plasticizers) are organic molecules added to a polymer to facilitate processing and to increase the flexibility and toughness of the final product by internally modifying (solvating) the polymer molecule. Plasticizing agents should be soluble in the polymer they are designed to plasticize, should not be highly water-soluble, and should be safe for the intended use. Suitable plasticizing agents in the present invention are nonvolatile organic liquids and low melting solids, such as esters of phthalic acid, adipic acid and sebacic acid, and polyols such as ethylene glycol and its derivatives, tricresyl phosphate, castor oil, and the like, and mixtures thereof. Other suitable partly water-soluble to water-insoluble plasticizing agents that may be incorporated in cellulosic dispersion products include dibutyl sebacate triethyl citrate, tributyl citrate, triacetin, and acetylated mono-, di- and triglycerides, and the like, and mixtures thereof. Other suitable plasticizing agents include acetyltriethylcitrate, triethyl-citrate, acetyltributylcitrate and tributylcitrate, and the like, and mixtures thereof. In a preferred embodiment, the plasticizing agent is acetyltributylcitrate, dibutyl sebacate, and mixtures thereof. In a more preferred embodiment, the plasticizing agent is dibutyl sebacate.

The amount of plasticizing agent present in the microcapsule composition and the coating layer composition will depend upon the amount of film forming polymer present in the respective compositions. Hence the amount of plasticizing agent present is set out above as "by weight of the film forming polymer." The amount of plasticizing agent present by weight of the microcapsule composition may be determined by multiplying the percentage of plasticizing agent present, by weight of the film forming polymer, by the percentage of film forming polymer present, by weight of the microcapsule composition. For example, when the amount of plasticizing agent present in the microcapsule composition is 5%, by weight of the film

forming polymer, and the amount of film forming polymer present in the microcapsule composition is 8%, by weight of the microcapsule composition, the amount of plasticizing agent present by weight of the microcapsule composition will be 0.4% (5% of 8%). The amount of plasticizing agent present by weight of the coating layer composition may be similarly determined by multiplying the percentage of plasticizing agent present, by weight of the film forming polymer, by the percentage of film forming polymer present, by weight of the coating layer composition.

Dispersing agents are surface-active agents added to a suspending medium to promote uniform separation of extremely fine (colloidal) solid particles. Suitable dispersing agents, when present, include polymeric electrolytes, condensed silicates, polyphosphates, lignin derivatives including aluminum stearate, aluminum laurate, magnesium stearate, calcium stearate, zinc stearate, talc, kaolin, fumed silica, and the like, and mixtures thereof. In a preferred embodiment, the dispersing agent is selected from the group consisting of aluminum stearate, kaolin, fumed silica, and mixtures thereof. In a more preferred embodiment, the dispersing agent is aluminum stearate.

The microcapsules of the present invention have a diameter under about 150 microns, preferably under about 100 microns, and most preferably under about 50 microns. The spray dried microcapsules formed in the present invention are spheroidal, that is, the microcapsules formed resemble spheres.

In another embodiment, the invention is directed at spheroidal coated microcapsules under about 850 microns in diameter which comprise at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, wherein the coated microcapsules comprise:

- (A) a microcapsule core comprising in percentages by weight of the core composition:
 - (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule core; and
- (B) a coating layer over the core comprising:
 - (a) a film forming polymer; and
 - (b) plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer.

In an alternative embodiment, the coating layer of the coated microcapsule may further comprise a dispersing agent present in an amount up to about 12%, preferably in an amount up to about 10%, and more preferably in an amount up to about 7%, by weight of the coating layer composition.

The film forming polymers, plasticizing agents and dispersing agents set out above as suitable for use in the spray dried spheroidal microcapsule may also be used in the coating layer.

The plasticizing agent in the coating layer is preferably present, in percentages by weight of the film forming polymer in the coating layer, in the range from about 5% to about 30%, more preferably from about 5% to about 24%, and most preferably from about 5% to about 20%. The dispersing agent in the coating layer, when present, is preferably present in an amount up to about 12%, more preferably in an amount up to about 10%, and most preferably from about 1% to about 7%, by weight of the coating layer composition.

The weight ratio of microcapsule core composition to coating layer composition is the ratio containing sufficient coating layer to prevent potential premature release of the medicament from the microcapsule core without forming a composition so large so as to be therapeutically unsuitable for use in chewable compositions. In general, the weight ratio of microcapsule core composition to coating layer composition is from about 1:9 to about 9:1, preferably from about 1:4 to about 1:1, and more preferably from about 1:4 to about 1:2, respectively.

The spheroidal coated microcapsules of the present invention have a diameter under about 850 microns, preferably under about 600 microns, and most preferably under about 500 microns. The spheroidal coated microcapsules may also be agglomerates of coated microcapsules which may contain one or more core microcapsule gathered into a cluster under a single coating layer. The terms "coated microcapsules" and "agglomerates of coated microcapsules" are used interchangeably herein.

The present invention is also directed at a method for preparing spray dried spheroidal microcapsules under about 150 microns in diameter, which comprises the steps of:

- (A) providing the following ingredients, in percentages by weight of the microcapsule composition:
 - (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule; and
- (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration from about 0.25% to about 50%, and the film forming polymer is present in

a concentration from about 5% to about 40%, by weight of the aqueous mixture; and
(C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under controlled conditions such that spheroidal microcapsules under about 150 microns in diameter are formed.

The concentration of the aqueous mixture of medicament in step (B) is sufficiently dilute to prevent coagulation of the medicament. In a preferred embodiment, the concentration of the medicament in step (B) is from about 0.25% to about 50%, preferably from about 1% to about 35%, and most preferably from about 3% to about 25%, by weight of the aqueous mixture.

The concentration of the aqueous mixture of film forming polymer in step (B) is sufficiently dilute to prevent coagulation of the film forming polymer. In a preferred embodiment, the concentration of the film forming polymer in step (B) is from about 5% to about 40%, preferably from about 10% to about 35%, and most preferably from about 10% to about 30%, by weight of the aqueous mixture.

The aqueous homogeneous mixture of step (B) in the method of the present invention is spray dried in step (C) under controlled conditions such that the mixture is flash dried and spheroidal microcapsules of under about 150 microns in diameter are formed. Flash drying (the rapid evaporation of solvent) involves the optimization of various parameters in the spray drying process such as the liquid feed rate, the air flow rate, the nozzle setting, the pressure of the system and the air inlet and air outlet temperatures. For example, the air outlet temperature must be sufficiently high so that sufficient heat is available to rapidly dry the spray and form small spheroidal microcapsules. The air outlet temperature is dependent upon such other parameters as the air inlet temperature and the liquid feed rate. The aqueous mixture of the present invention may be flash dried using standard techniques and equipment known to those skilled in the art. The exact conditions for flash drying will vary with the particular apparatus selected and are readily determined by those skilled in the art without the need for undue experimentation. Spray drying apparatus is well known in the arts and therefore the selection of the specific apparatus will be apparent to the artisan.

In a preferred embodiment, the spray drying apparatus is a Büchi 190 Mini Spray dryer. In this embodiment, the liquid feed rate is preferably from about 5 ml/min. to about 25 ml/min., more preferably from about 7 ml/min. to about 22 ml/min., and most preferably from about 9 ml/min. to about 20 ml/min. The air flow rate is preferably from about 300 Nl/h (normiliters per hour) to about 750 Nl/h, and more preferably from about 400 Nl/h to about 700 Nl/h, and most preferably from about 500 Nl/h to about 700 Nl/h. The nozzle setting is preferably from about 0.8 mm to about 2.0 mm, more preferably from about 0.8 mm to about 1.5 mm, and most preferably from about mm to about 1.5 mm. The pressure of the system (system pressure) is preferably from about 25 mm/Hg to about 50 mm/Hg, more preferably from about 30 mm/Hg to about 50 mm/Hg, and most preferably from about 35 mm/Hg to about 50 mm/Hg. The air inlet temperature of the spray dryer is preferably from about 60° C. to about 145° C., more preferably from about 80° C. to about 140° C., and most preferably from about 85° C. to about 135° C. The air outlet temperature of the spray dryer is preferably from about 40° C. to about 90° C., more preferably from about 45° C. to about 90° C., and most preferably from about 50° C. to about 80° C.

In another embodiment, the present invention is directed at a method for preparing spheroidal coated microcapsules under about 850 microns in diameter which comprise at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, which comprises the steps of:

- (A) providing the following ingredients of the microcapsule core, in percentages by weight of the core composition:
 - (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule core; and
- (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration from about 0.25% to about 50%, and the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture;
- (C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under controlled conditions such that spheroidal microcapsules under about 150 microns in diameter are formed;
- (D) providing the following ingredients of the coating layer:
 - (a) a film forming polymer; and
 - (b) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer; and
- (E) preparing an aqueous homogeneous mixture of the ingredients in step (D), wherein the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture; and

(F) coating the spray dried microcapsules from step (C) with the coating layer mixture from step (E) in a fluid bed dryer by suspending the microcapsules in a stream of air passing through a zone of the coating layer mixture under controlled conditions such that spheroidal coated microcapsules under about 850 microns in diameter are formed.

- 5 The concentration of the aqueous mixture of film forming polymer in step (E) is sufficiently dilute to prevent coagulation of the film forming polymer. In a preferred embodiment, the concentration of the film forming polymer in step (E) is from about 5% to about 40%, preferably from about 5% to about 30%, and more preferably from about 5% to about 20%, by weight of the aqueous mixture.

- 10 The spheroidal microcapsules from step (C) in the present invention are spray (film) coated in step (F) in a fluid bed dryer by suspending the microcapsules in a stream of air or strong upward air current and passing the stream through a zone of finely atomized droplets of the coating layer mixture (encapsulants), after which the coated particles pass out of the upward stream and pass downward in a fluidized condition countercurrent to a flow of heated fluidized gas whereupon they are dried, and may re-enter the upward-moving coating zone for a subsequent discreet coating application. The microcapsules of the present invention are spray coated under controlled conditions such that spheroidal coated microcapsules under about 850 microns in diameter are formed. The microcapsules of the present invention may be spray coated using standard techniques and equipment known to those skilled in the art. The exact conditions for spray coating will vary with the particular fluid bed apparatus selected and are readily determined by those skilled in the art without the need for undue experimentation. Fluid bed apparatus is well known in the arts and therefore the selection of the specific apparatus will be apparent to the artisan.

- 20 In one embodiment, the method and apparatus employed is known as the Wurster Process. The Wurster Process and its associated apparatus are disclosed in detail, for example, in United States patents no. 3,089,824, 3,117,027, 3,196,827, 3,241,520, and 3,253,944, which disclosures are incorporated herein by reference.

- 25 In a preferred embodiment, the apparatus is a Versa-Glatt model GPCG 1 fluidized bed apparatus with a Wurster column. In this preferred embodiment, the spray rate during the coating in step (F) is preferably from about 2 ml/min. to about 10 ml/min., more preferably from about 2 ml/min. to about 7 ml/min., and most preferably from about 2 ml/min. to about 6 ml/min. The fluidizing (atomizing) air pressure in step (F) is preferably from about 1 atmosphere to about 5 atmospheres, more preferably from about 1 atmosphere to about 4.5 atmospheres, and most preferably from about 1 atmosphere to about 4 atmospheres. The nozzle used in step (F) is preferably from about 0.8 mm to about 2 mm, more preferably from about 0.8 mm to about 1.5 mm, and most preferably from about 0.8 mm to about 1.2 mm. The inlet temperature in step (F) is preferably from about 35° C. to about 65° C., more preferably from about 35° C. to about 60° C., and most preferably from about 40° C. to about 55° C. The outlet temperature in step (F) is preferably from about 20° C. to about 50° C., more preferably from about 25° C. to about 50° C., and most preferably from about 30° C. to about 50° C.

- 35 In another embodiment, the present invention is directed at spray dried spheroidal microcapsules under about 150 microns in diameter prepared by a method which comprises the steps of:

- 40 (A) providing the following ingredients, in percentages by weight of the microcapsule composition:
- (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule; and
- 45 (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration from about 0.25% to about 50%, and the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture; and
- (C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under controlled conditions such that spheroidal microcapsules under about 150 microns in diameter are formed.

- 50 In another embodiment, the present invention is directed at a spheroidal coated microcapsule under about 850 microns in diameter which comprises at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, prepared by a method which comprises the steps of:

- (A) providing the following ingredients of the microcapsule core, in percentages by weight of the core composition:
- 55 (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule core; and

- (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration from about 0.25% to about 50%, and the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture;
- (C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under control led conditions such that spheroidal microcapsules under about 150 microns in diameter are formed;
- (D) providing the following ingredients of the coating layer:
- (a) a film forming polymer; and
 - (b) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer; and
- (E) preparing an aqueous homogeneous mixture of the ingredients in step (D), wherein the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture; and
- (F) coating the spray dried microcapsules from step (C) with the coating layer mixture from step (E) in a fluid bed dryer by suspending the microcapsules in a stream of air passing through a zone of the coating layer mixture under control led conditions such that spheroidal coated microcapsules under about 850 microns in diameter are formed.

Once prepared, the chewable spray dried spheroidal microcapsule and coated microcapsule compositions may be stored for future use or may be formulated with conventional additives such as pharmaceutically acceptable carriers and confectionery bulking agents to prepare a wide variety of chewable medicated compositions and sustained release compositions to suit particular applications.

An important aspect of the present invention includes a hard or soft confectionery composition incorporating the inventive spray dried spheroidal microcapsules and coated microcapsule compositions and a method for preparing the hard or soft confections. In this form of the invention, the spray dried spheroidal microcapsules and coated microcapsules include a pharmaceutically acceptable carrier such as a confectionery bulking agent, the inventive chewable microcapsule compositions, and various additives. The confectionery may be in the form of a lozenge, tablet, toffee, nougat, suspension, chewy candy, and the like. The pharmaceutically acceptable carriers may be prepared from a wide range of materials. Without being limited thereto, such materials include diluents, binders and adhesives, lubricants, disintegrants, coloring agents, bulking agents, flavoring agents, sweetening agents and miscellaneous materials such as buffers and adsorbents in order to prepare a particular medicated chewable confection.

The preparation of confectionery formulations is historically well known and has changed little through the years. Confectionery items have been classified as either "hard" confectionery or "soft" confectionery. The chewable medicated compositions of the present invention can be incorporated into confectionery compositions by admixing the inventive compositions into conventional hard and soft confections.

As used herein, the term confectionery material means a product containing a bulking agent selected from a wide variety of materials such as sugar, corn syrup, and the like, and in the case of sugarless bulking agents, sugar alcohols such as sorbitol and mannitol and the like, and mixtures thereof. Confectionery material may include such exemplary substances as lozenges, tablets, toffee, nougat, suspensions, chewy candy, chewing gum and the like. The bulking agent is present in a quantity sufficient to bring the total amount of confectionery composition to 100%.

Lozenges are flavored medicated dosage forms intended to be sucked and held in the mouth. Lozenges may be in the form of various shapes such as flat, circular, octagonal and biconvex forms. The lozenge bases are generally in two forms: hard, boiled candy lozenges and compressed tablet lozenges.

Hard boiled candy lozenges may be processed and formulated by conventional means. In general, a hard boiled candy lozenge has a base composed of a mixture of sugar and other carbohydrate bulking agents kept in an amorphous or glassy condition. This amorphous or glassy form is considered a solid syrup of sugars generally having from about 0.5% to about 1.5% moisture. Such materials normally contain up to about 82% corn syrup, up to about 55% sugar and from about 0.1% to about 5% water, by weight of the final composition. The syrup component is generally prepared from corn syrups high in fructose, but may include other materials. Further ingredients such as flavoring agents, sweetening agents, acidulants, coloring agents and the like may also be added.

Boiled candy lozenges may also be prepared from non-fermentable sugars such as sorbitol, mannitol, and hydrogenated corn syrup. Typical hydrogenated corn syrups are Lycasin, a commercially available product manufactured by Roquette Corporation, and Hystar, a commercially available product manufactured by Lonza, Inc. The candy lozenges may contain up to about 95% sorbitol, a mixture of sorbitol and mannitol in a ratio from about 8.5:0.5 up to about 7.5:2.5, and hydrogenated corn syrup up to about 55%, by weight of the solid syrup component.

Boiled candy lozenges may be routinely prepared by conventional methods such as those involving fine

cookers, vacuum cookers, and scraped-surface cookers also referred to as high speed atmospheric cookers.

Fire cookers involve the traditional method of making a boiled candy lozenge base. In this method, the desired quantity of carbohydrate bulking agent is dissolved in water by heating the agent in a kettle until the bulking agent dissolves. Additional bulking agent may then be added and the cooking continued until a final temperature of 145° C. to 156° C. is achieved. The batch is then cooled and worked as a plastic-like mass to incorporate additives such as flavoring agents, coloring agents and the like.

A high-speed atmospheric cooker uses a heat-exchanger surface which involves spreading a film of candy on a heat exchange surface, the candy is heated to 165° C. to 170° C. in a few minutes. The candy is then rapidly cooled to 100° C. to 120° C. and worked as a plastic-like mass enabling incorporation of the additives, such as flavor agents, coloring agents and the like.

In vacuum cookers, the carbohydrate bulking agent is boiled at a temperature from about 125° C. to about 132° C., vacuum is applied and additional water is boiled off without extra heating. When cooking is complete, the mass is a semi-solid and has a plastic-like consistency. At this point, flavoring agents, coloring agents, and other additives are admixed in the mass by routine mechanical mixing operations.

The optimum mixing required to uniformly mix the flavoring agents, coloring agents and other additives during conventional manufacturing of boiled candy lozenges is determined by the time needed to obtain a uniform distribution of the materials. Normally, mixing times of from about 4 to about 10 minutes have been found to be acceptable.

Once the boiled candy lozenge has been properly tempered, it may be cut into workable portions or formed into desired shapes. A variety of forming techniques may be utilized depending upon the shape and size of the final product desired. A general discussion of the composition and preparation of hard confections may be found in H.A. Lieberman, *Pharmaceutical Dosage Forms: Tablets*, Volume 1 (1960), Marcel Dekker, Inc., New York, N.Y. at pages 339 to 469, which disclosure is incorporated herein by reference.

The apparatus useful in accordance with the present invention comprises cooking and mixing apparatus well known in the confectionery manufacturing arts, and therefore the selection of the specific apparatus will be apparent to the artisan.

In contrast, compressed tablet confections contain particulate materials and are formed into structures under pressure. These confections generally contain sugars in amounts up to about 95%, by weight of the composition, and typical tablet excipients such as binders and lubricants as well as flavoring agents, coloring agents and the like.

In addition to hard confectionery materials, the lozenges of the present invention may be made of soft confectionery materials such as those contained in nougat. The preparation of soft confections, such as nougat, involves conventional methods, such as the combination of two primary components, namely (1) a high boiling syrup such as a corn syrup, hydrogenated starch hydrolysate or the like, and (2) a relatively light textured frappe, generally prepared from egg albumin, gelatin, vegetable proteins, such as soy derived compounds, sugarless milk derived compounds such as milk proteins, and mixtures thereof. The frappe is generally relatively light, and may, for example, range in density from about 0.5 to about 0.7 grams/cc.

The high boiling syrup, or "bob syrup" of the soft confectionery is relatively viscous and has a higher density than the frappe component, and frequently contains a substantial amount of carbohydrate bulking agent such as a hydrogenated starch hydrolysate. Conventionally, the final nougat composition is prepared by the addition of the "bob syrup" to the frappe under agitation, to form the basic nougat mixture. Further ingredients such as flavoring agents, additional carbohydrate bulking agents, coloring agents, preservatives, medicaments, mixtures thereof and the like may be added thereafter also under agitation. A general discussion of the composition and preparation of nougat confections may be found in B.W. Minifie, *Chocolate, Cocoa and Confectionery: Science and Technology*, 2nd edition, AVI Publishing Co., Inc., Westport, Conn. (1980), at pages 424-425, which disclosure is incorporated herein by reference.

The procedure for preparing the soft confectionery involves known procedures. In general, the frappe component is prepared first and thereafter the syrup component is slowly added under agitation at a temperature of at least about 65° C., and preferably at least about 100° C. The mixture of components is continued to be mixed to form a uniform mixture, after which the mixture is cooled to a temperature below 80° C., at which point, the flavoring agent may be added. The mixture is further mixed for an additional period until it is ready to be removed and formed into suitable confectionery shapes.

The novel chewable medicated microcapsules and sustained release compositions may also be in the form of a pharmaceutical suspension. Pharmaceutical suspensions of this invention may be prepared by conventional methods long established in the art of pharmaceutical compounding. Suspensions may contain adjunct materials employed in formulating the suspensions of the art. The suspensions of the present

invention can comprise:

- (a) preservatives such as benzoic acid, sorbic acid, methyl paraben, and propyl paraben. Preservatives are generally present in amounts up to about 1%, and preferably from about 0.05% to about 0.5%, by weight of the suspension;
- 5 (b) buffers such as citric acid-sodium citrate, phosphoric acid-sodium phosphate, and acetic acid-sodium acetate which may be present in amounts up to about 1%, and preferably from about 0.05% to about 0.5%, by weight of the suspension;
- (c) suspending agents or thickeners such as cellulose like methylcellulose, carrageenans like alginic acid and its derivatives, xanthan gums, gelatin, acacia, and microcrystalline cellulose which may be present in amounts up to about 20%, and preferably from about 1% to about 15%, by weight of the suspension;
- 10 (d) antifoaming agents such as dimethyl polysiloxane which may be present in amounts up to about 0.2%, and preferably from about 0.01% to about 0.1%, by weight of the suspension;
- (e) sweetening agents such as those sweeteners well known in the art, including both natural and artificial sweeteners. Sweetening agents such as monosaccharides, disaccharides and polysaccharides such as xylitol, ribitol, glucose (dextrose), mannose, galactose, fructose (levulose), sucrose (sugar) maltose, invert sugar (a mixture of fructose and glucose derived from sucrose), partially hydrolyzed starch, corn syrup solids, dihydrochalcones, monellin, steviolides, glycyrrhizin, and sugar alcohols such as sorbitol, mannitol, malitol, hydrogenated starch hydrolysates and mixtures thereof may be utilized in amounts up to about 80%, and preferably from about 20% to about 50%, by weight of the suspension. Water-soluble artificial sweeteners such as soluble saccharin salts, i.e., sodium or calcium saccharin salts, cyclamate salts, the sodium, ammonium or calcium salt of 3,4-dihydro-6-methyl-1,2,3-oxathiazine-4-one-2,2-dioxide, the potassium salt of 3,4-dihydro-6-methyl-1,2,3-oxathiazine-4-one-2,2-dioxide (Acesulfame-K), the free acid form of saccharin, and the like may be utilized in amounts from about 0.001% to about 5%, by weight of the suspension;
- 15 (f) flavoring agents such as those flavors well known to the skilled artisan, such as natural and artificial flavors and mints, such as peppermint, menthol, citrus flavors such as orange and lemon, artificial vanilla, cinnamon, various fruit flavors, both individual and mixed and the like may be utilized in amounts from about 0.5% to about 5%, by weight of the suspension;
- 20 (g) coloring agents such as pigments which may be incorporated in amounts up to about 8%, by weight of the suspension. A preferred pigment, titanium dioxide, may be incorporated in amounts up to about 2%, and preferably less than about 1%, by weight of the suspension. The coloring agents may also include natural food colors and dyes suitable for food, drug and cosmetic applications. These coloring agents are known as F.D. & C. dyes and lakes. The materials acceptable for the foregoing uses are preferably water-soluble. Such dyes are generally present in amounts up to about 0.25%, and preferably from about 0.05% to about 0.2%, by weight of the suspension;
- 25 (h) decolorizing agents such as sodium metabisulfite, ascorbic acid and the like may be incorporated into the suspension to prevent color changes due to aging. In general, decolorizing agents may be used in amounts up to about 0.25%, and preferably from about 0.05% to about 0.2%, by weight of the suspension; and
- 30 (i) vehicles such as alcohol, propylene glycol, polyethylene glycol, edible oils such as animal, vegetable and mineral oils, and the like may be used to solubilize the flavoring agents. In general, vehicles may be used in amounts up to about 10%, and preferably from about 2% to about 5%, by weight of the suspension.
- 35 The pharmaceutical suspensions of the present invention may be prepared as follows:
- (A) admix the thickener with the vehicle heated to a temperature from about 40° C. to about 95° C., preferably from about 40° C. to about 70° C., to form a dispersion if the thickener is soluble in the vehicle or a solution if the thickener is soluble in the soluble;
- 40 (B) admix the sweetening agent with the vehicle to form a solution;
- 45 (C) admix the sustained release composition with the thickener-vehicle admixture to form a uniform thickener-sustained release composition;
- 50 (D) combine the sweetener solution with the thickener-sustained release composition and mix until uniform; and
- 55 (E) admix the optional adjunct materials such as coloring agents, flavoring agents, decolorants, solubilizing agents, antifoaming agents, buffers and additional vehicle with the mixture of step (D) to form the suspension.

To achieve acceptable stability and quality as well as good taste and mouth feel in a chewable sustained release formulation several considerations are important. These considerations include the

amount of active substance per tablet, the flavoring agent employed, the degree of compressibility of the tablet and the organoleptic properties of the pharmaceutical composition.

Chewable medicated candy is prepared by procedures similar to those used to make soft confectionery. In a typical procedure, a boiled sugar-corn syrup blend is formed to which is added a frappe mixture. The boiled sugar-corn syrup blend may be prepared from sugar and corn syrup blended in parts by weight ratio of about 90:10 to about 10:90. The sugar-corn syrup blend is heated to temperatures above about 120° C. to remove water and to form a molten mass. The frappe is generally prepared from gelatin, egg albumin, milk proteins such as casein, and vegetable proteins such as soy protein, and the like, which is added to a gelatin solution and rapidly mixed at ambient temperature to form an aerated sponge like mass. The frappe is then added to the molten candy mass and mixed until homogeneous at temperatures between about 65° C. and about 120° C.

The spray dried spheroidal microcapsules and sustained release compositions of the instant invention can then be added to the homogeneous mixture as the temperature is lowered to about 65° C.-95° C. whereupon additional ingredients can then be added such as flavoring agents and coloring agents. The formulation is further cooled and formed into pieces of desired dimensions.

A general discussion of the lozenge and chewable tablet forms of confectionery may be found in H.A. Lieberman and L. Lachman, *Pharmaceutical Dosage Forms: Tablets* Volume 1, Marcel Dekker, Inc., New York, N.Y. at pages 289 to 466, which disclosure is incorporated herein by reference.

In accordance with this invention, therapeutically effective amounts of the chewable microcapsule and coated microcapsule compositions of the present invention may be admixed into the hard and soft confections. These amounts are readily determined by those skilled in the art without the need for undue experimentation. The exact amount of the spray dried spheroidal microcapsules and coated microcapsules employed in the hard and soft confections will vary with the particular medicament selected. In a preferred embodiment, the spray dried spheroidal microcapsules and coated microcapsules are present in the hard and soft confection compositions in percentages by weight in an amount from about 5% to about 50%, more preferably from about 10% to about 40%, and most preferably, in an amount from about 10% to about 30%. The pharmaceutically acceptable carrier and optional additives are present in a quantity sufficient to bring the total amount of hard and soft confection composition to 100%.

The present invention extends to methods of making the improved chewable medicated hard and soft confection compositions. The medicated microcapsule compositions may be incorporated into otherwise conventional hard or soft confection compositions using standard techniques and equipment known to those skilled in the art.

The apparatus useful in accordance with the present invention comprises cooking and mixing apparatus well known in the confectionery manufacturing arts, and therefore the selection of the specific apparatus will be apparent to the artisan.

In one embodiment, the present invention is directed at a chewable medicated composition which comprises a pharmaceutically acceptable carrier and a therapeutically effective amount of spray dried spheroidal microcapsules under about 150 microns in diameter, wherein the microcapsules comprise in percentages by weight of the microcapsule composition:

- (a) a medicament present in an amount from about 1% to about 80%;
- (b) a film forming polymer present in an amount from about 8% to about 90%; and
- (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule.

In another embodiment, the present invention is directed at a chewable sustained release medicated composition which comprises a pharmaceutically acceptable carrier and a therapeutically effective amount of spheroidal coated microcapsules under about 850 microns in diameter which comprise a least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, wherein the coated microcapsules comprise:

- (A) a microcapsule core comprising in percentages by weight of the core composition:
 - (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule core; and
- (B) a coating layer over the core comprising:
 - (a) a film forming polymer; and
 - (b) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer.

In another embodiment, the present invention is directed at a chewable medicated composition which

comprises a pharmaceutically acceptable carrier and a therapeutically effective amount of spray dried spheroidal microcapsules under about 150 microns in diameter, wherein the microcapsules are prepared by a method which comprises the steps of:

- (A) providing the following ingredients, in percentages by weight of the microcapsule composition:
 - (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule; and
 - (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration from about 0.25% to about 50%, and the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture; and
 - (C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under controlled conditions such that spheroidal microcapsules under about 150 microns in diameter are formed.
- In another embodiment, the present invention is directed at a chewable sustained release medicated composition which comprises a pharmaceutically acceptable carrier and a therapeutically effective amount of spheroidal coated microcapsules under about 850 microns in diameter which comprise at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, wherein the coated microcapsules are prepared by a method which comprises the steps of:
- (A) providing the following ingredients of the microcapsule core, in percentages by weight of the core composition:
 - (a) a medicament present in an amount from about 1% to about 90%;
 - (b) a film forming polymer present in an amount from about 8% to about 90%; and
 - (c) a plasticizing agent present in an amount from about 5% to about 30%, in percentages by weight of the film forming polymer in the microcapsule core; and
 - (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration from about 0.25% to about 50%, and the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture;
 - (C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under controlled conditions such that spheroidal microcapsules under about 150 microns in diameter are formed;
 - (D) providing the following ingredients of the coating layer:
 - (a) a film forming polymer; and
 - (b) a plasticizing agent present in an amount from about 5% to about 30%, by weight of the film forming polymer; and
 - (E) preparing an aqueous homogeneous mixture of the ingredients in step (D), wherein the film forming polymer is present in a concentration from about 5% to about 40%, by weight of the aqueous mixture; and
 - (F) coating the spray dried microcapsules from step (C) with the coating layer mixture from step (E) in a fluid bed dryer by suspending the microcapsules in a stream of air passing through a zone of the coating layer mixture under controlled conditions such that spheroidal coated microcapsules under about 850 microns in diameter are formed.
- The present invention is further illustrated by the following examples which are not intended to limit the effective scope of the claims. All parts and percentages in the examples and throughout the specification and claims are by weight of the final composition unless otherwise specified.

EXAMPLE 1

This Example demonstrates a method for preparing spray dried spheroidal microcapsules and coated microcapsules according to the process of the present invention.

A spray dried spheroidal microcapsule or core particle was prepared having the composition set out in Table 1.

TABLE 1
SPRAY DRIED MICROCAPSULE COMPOSITION

INGREDIENT	AMOUNT	% BY WEIGHT MICROCAPSULE	% BY WEIGHT AQUEOUS MIXTURE
Pseudoephedrine sulfate	150g	16.4	2.87
Aluminum stearate	15g	1.6	0.30
Ethyl Cellulose [5000g of a 25% aqueous suspension of SURELEASE]	750g	82.0	14.33
1% Ammonium hydroxide	2070g		

Pseudoephedrine sulfate and aluminum stearate were slurried in the 1% ammonium hydroxide aqueous solution. The aqueous suspension of ethyl cellulose and plasticizing agent were admixed to the slurry and the slurry was mixed at about 30 rpm to form a uniform dispersion. The resulting mixture was spray dried in a Büchi 190 Mini Spray dryer wherein the liquid feed rate was 15 ml/minute, the air flow rate was 600 Nl/h, the nozzle setting was 1.2 mm, the system pressure was 45 mm/Hg, the air inlet temperature was from about 90° C. to about 110° C., and the air outlet temperature was from about 55° C. to about 65° C. A quantity of 810g of the spray dried microcapsules containing pseudoephedrine sulfate were obtained which were passed through a 100 mesh screen (greater than 90% of the microcapsules passed through the screen).

A quantity of 200g of the pseudoephedrine sulfate microcapsule core material prepared above was coated with a coating layer material which had the composition set out in Table 2.

TABLE 2

COATING LAYER COMPOSITION	
INGREDIENT	AMOUNT
Ethyl Cellulose [2000g of a 25% aqueous suspension of SURELEASE]	500g
Distilled water	400g

The coating material mixture was prepared by adding the distilled water to the ethyl cellulose aqueous suspension with constant stirring. The pseudoephedrine sulfate microcapsule core material prepared above was fluidized in a Versa-Glatt model GPCG 1 fluidized bed apparatus with a Wurster column. The pseudoephedrine sulfate microcapsules were then spray coated with the aqueous ethyl cellulose coating material mixture (about 13.9% solution) wherein the spray rate was 4-6 ml/min., the fluidizing air pressure was 4 atmospheres, the nozzle setting was 1.2 mm, the air outlet temperature was about 50° C., and the column height was 3/8 inch. Small agglomerates of film coated microcapsules were initially formed which were further coated with the aqueous film forming polymer suspension. The resulting film coated microcapsules were dried in the fluidized bed for 20 minutes at 60° C., then cured at 60° C. for 3 hours. A quantity of 600g of the film coated microcapsules were obtained which were separated into particles of the following mesh size: 30-40, 40-60, 60-80, and 80-100.

EXAMPLE 2

This Example demonstrates another method for preparing spray dried spheroidal microcapsules and coated microcapsules according to the process of the present invention.

A spray dried spheroidal microcapsule or core particle was prepared having the composition set out in Table 3.

TABLE 3
SPRAY DRIED MICROCAPSULE COMPOSITION

INGREDIENT	AMOUNT	% BY WEIGHT MICROCAPSULE	% BY WEIGHT AQUEOUS MIXTURE
Pseudoephedrine sulfate	150g	22.06	3.59
Aluminum stearate	30g	4.41	0.72
Ethyl Cellulose [2000g of a 25% aqueous suspension of SURELEASE]	500g	73.53	11.96
1% Ammonium hydroxide	1500g		

A homogeneous mixture of the above ingredients was prepared essentially according to the procedure of Example 1. The resulting mixture was spray dried in a Büchi 190 Mini Spray Dryer wherein the liquid feed rate was 20 ml/minute, the air flow rate was 600 Nl/h, the nozzle setting was 1.2 mm, the system pressure was mm/Hg, the air inlet temperature was from about 110° C. to about 115° C., and the air outlet temperature was from about 60° C. to about 66° C. A quantity of 610g of the spray, dried microcapsules containing pseudoephedrine sulfate were obtained which were passed through a 100 mesh screen (greater than 90% of the microcapsules passed through the screen).

A quantity of 238g of the spray dried microcapsule core material containing pseudoephedrine sulfate prepared above and 50g of kaolin were thoroughly mixed and coated with a coating material which had the composition set out in Table 4.

TABLE 4

COATING LAYER COMPOSITION	
INGREDIENT	AMOUNT
Ethyl cellulose [1990g of a 30% aqueous solution]	597g
Citroflex 2	89.55g
Citroflex A2	59.70g
Distilled water	450ml

The aqueous film forming polymer suspension was thoroughly mixed with the plasticizing agents. The pseudoephedrine sulfate microcapsule core material prepared above was fluidized in a Versa-Glatt model GPCG 1 fluidized bed apparatus with a Wurster column. The pseudoephedrine sulfate microcapsules from above were then spray coated with the aqueous ethyl cellulose coating material (about 14.98% solution) essentially according to the procedure set out in Example 1 wherein the spray rate was 2-5 ml/min., the fluidizing air pressure was 4 atmospheres, the nozzle setting was 1.2 mm, the air outlet temperature was about 30° C., and the column height was 3/8 inch. Small agglomerates of film coated microcapsules were initially formed which were further coated with the aqueous film forming polymer suspension. The resulting coated microcapsules were dried in the fluidized bed for 20 minutes at 60° C. and cured at 60° C. for three hours. A quantity of 860g of the film coated microcapsules were obtained which were separated into particles of the following mesh size: 30-40, 40-60, 60-80, and 80-100.

EXAMPLE 3

This Example demonstrates the sustained release properties (dissolution) of the ethylcellulose coated pseudoephedrine sulfate microcapsules prepared in Examples 1 and 2 in unfilled gelatin capsules.

Samples 1-6 were prepared using unfilled size 0 gelatin capsules having the ingredients set out in Table 5.

TABLE 5

GELATIN CAPSULE SAMPLES	
SAMPLE	INGREDIENTS
1	0.43573g of 30-40 mesh coated microcapsules from Example 1
2	0.43574g of 40-60 mesh coated microcapsules from Example 1
3	0.56394g of 40-60 mesh coated microcapsules from Example 1
4	0.64689g of 60-80 mesh coated microcapsules from Example 1
5	0.67273g of 60-80 mesh coated microcapsules from Example 2
6	0.55132g of 80-100 mesh coated microcapsules from Example 2

Samples 1-6 were weighed out in the gelatin capsules and stirred at 50 rpm in 900ml of distilled water at a temperature of 37° C. The dissolution of the medicament from the coated microcapsules was measured by High Pressure Liquid Chromatography using an ultraviolet detector. The results of the dissolution study are set out in Table 6.

TABLE 6

TIME (hours)	DISSOLUTION STUDY					
	SAMPLE (% Dissolution by Weight)					
	1	2	3	4	5	6
1	32.44	31.73	29.52	35.13	47.26	39.71
2	43.29	44.20	42.53	55.52	63.54	58.08
4	61.20	65.40	66.57	78.44	75.17	73.27
6	73.74	76.52	78.13	90.44	80.67	80.30
8	85.14	87.36	85.73	93.35	88.44	84.94
12	87.83	91.15	93.04	93.81	93.18	91.62
16	92.80	95.02	94.15	99.45	93.79	95.04
20	92.24	100.0	99.52	100.0	98.51	99.61

Table 6 shows that coated microcapsules having a particle size between about 20 and 60 mesh size have slower release rates than coated microcapsules having a particle size between about 60 and about 100 mesh. Hence microcapsules having a higher level of coating layer have a slower release rate.

EXAMPLE 4

This Example demonstrates the sustained release properties (dissolution) of the ethylcellulose coated pseudoephedrine sulfate microcapsules prepared in Examples 1 and 2 in nougat compositions. Nougat samples 7-10 were prepared having the compositions set out in Table 7.

TABLE 7

NOUGAT SAMPLES	
SAMPLE	INGREDIENTS
7	2.40203g of 40-60 mesh coated microcapsules from Example 1 0.90585g hard palm oil 0.90187g of paramount c 0.60632g cetodan 700 3.27875g nougat
8	2.40276g of 40-60 mesh coated microcapsules from Example 1 1.80368g Dm-Sm 117k 0.60501g cetodan 700 3.20498g nougat
9	2.40608g of 60-80 mesh coated microcapsules from Example 2 1.80130g Dur 17 0.60260g cetodan 700 3.20449g nougat
10	1.80837g of 40-60 mesh coated microcapsules from Example 1 6.20000g nougat

The nougat pieces from samples 7-10 were cut into 32 pieces and then stirred at 50 rpm in 1000ml of distilled water at a temperature of 37° C. The dissolution of the medicament from the coated microcapsules in nougat was measured by High Pressure Liquid Chromatography using an ultraviolet detector. The results of the dissolution study are set out in Table 8.

TABLE 8

DISSOLUTION STUDY				
TIME (hours)	SAMPLE (% Dissolution by Weight)			
	7	8	9	10
1	23.83	16.80	18.88	20.15
2	48.91	24.24	26.66	32.68
4	73.02	34.49	39.95	51.67
6	84.26	41.48	50.94	68.36
8	92.62	48.87	59.05	82.29
12	96.34	65.69	75.97	87.00
16	97.44	78.39	89.02	92.61
24	—	91.02	90.92	93.15

Table 8 shows that coated microcapsules in nougat have a release rate similar to the release rate of the coated microcapsules in Table 6. However the coated microcapsules dispersed in fat (sample 7) have an enhanced release rate.

EXAMPLE 5

This Example demonstrates another method for preparing spray dried spheroidal microcapsules and coated microcapsules according to the process of the present invention.

A spray dried spheroidal microcapsule or core particle was prepared having the composition set out in Table 9.

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TABLE 9

SPRAY DRIED MICROCAPSULE COMPOSITION			
INGREDIENT	AMOUNT	% BY WEIGHT MICROCAPSULE	% BY WEIGHT AQ. MIXTURE
Pseudoephedrine sulfate	660g	26.77	4.79%
Aluminum stearate	264g	10.71	1.91%
Ethyl cellulose [6424g of a 24% aqueous suspension of SURELEASE]	1542g	62.53	11.20%
1% Ammonium hydroxide	13,377 g		

A homogeneous mixture of the above ingredients was prepared essentially according to the procedure of Example 1. The resulting mixture was spray dried in a Büchi 190 Mini Spray Dryer wherein the liquid feed rate was 15 ml/minute, the air flow rate was 600 N/h, the nozzle setting was 1.2 mm, the system pressure was 45 mm/Hg, the air inlet temperature was from about 114° C. to about 130° C., and the air outlet temperature was from about 55° C. to about 80° C. A quantity of 1335g of the spray dried microcapsules containing pseudoephedrine sulfate were obtained which were passed through an 80 mesh screen (greater than 90% of the microcapsules passed through the screen).

A quantity of 746.5g of the spray dried microcapsule core material containing pseudoephedrine sulfate prepared above was spray coated with SURELEASE (24% aqueous suspension of ethyl cellulose with plasticizing agent diluted 1:1 with distilled water to prepare a 12% aqueous suspension) essentially according to the procedure set out in Example 1. The spray coating was carried out at a spray rate of 4-6 ml/min., a fluidizing air pressure of 20 psi, a nozzle setting of 1.2 mm, an air outlet temperature of about 30-35° C., and a column height of 15 mm. Small agglomerates of film coated microcapsules were initially formed. Portions of these coated microcapsules were further coated with the aqueous film forming polymer suspension. The resulting coated microcapsules were dried in the fluidized bed for 20 minutes at 80° C. and cured at 60° C. for three hours. The compositions of the coated microcapsules with different levels of polymer coating are set out in Table 10 as samples 11-13.

TABLE 10

COATED MICROCAPSULES		
SAMPLE	PERCENTAGE POLYMER COATED	PERCENTAGE PSEUDOEPHEDRINE SULFATE
11	64.8	9.42
12	66.7	8.91
13	77.13	6.12

The film coated microcapsules of samples 11 and 12 were separated into particles having the particle size distribution set out in Table 11.

TABLE 11

PARTICLE SIZE DISTRIBUTION		
Mesh Size	11	12
	(Percentage of Particles)	
30	2.61	1.88
40	26.58	32.89
60	80.65	53.19
80	7.95	9.31
100	1.28	1.93
140	0.84	0.76

The sustained release properties (dissolution) of the film coated microcapsules of samples 11 and 12 were measured by the paddle method (The United States Pharmacopeia XXI) at 100 rpm at 37° C. The dissolution of the medicament from the coated microcapsules was measured by High Pressure Liquid Chromatography using an ultraviolet detector. The results of the dissolution study are set out in Table 12.

TABLE 12

DISSOLUTION STUDY		
Time (hours)	SAMPLE (% Dissolution by Weight)	
	11	12
1	44.01	22.34
2	61.04	42.67
3	74.32	54.87
5	80.53	69.86
7	85.72	79.26
12	89.51	89.34
24	89.73	89.89

Table 12 shows that coated microcapsules having a higher level of coating layer (sample 12) have enhanced sustained release properties.

The film coated microcapsules of sample 13 were separated into particles having the particle size distribution set out in Table 13.

TABLE 13

PARTICLE SIZE DISTRIBUTION	
Mesh Size	13
	(Percentage of Particles)
30	7.97
40	49.04
60	39.87
80	2.94
100	0.11
140	0.07

The coated microcapsules from sample 13 were separated into the following sizes:

A. < 20 mesh

B. < 30 mesh

C. < 40 mesh

Nougat compositions were prepared from each of the above mesh sizes (A, B, and C) of the coated microcapsules of sample 13 essentially according to the method set out in Example 4. The chew characteristics of the nougats of the samples 13A, 13B and 13C were budged by an expert panel and are set out below in Table 14.

TABLE 14

CHEW CHARACTERISTICS			
Judge	13A	13B	13C
	(20 mesh)	(30 mesh)	(40 mesh)
1	good	good	very good
2	good	good	good
3	slightly grainy	good	good

Table 14 shows that the chew characteristics of the coated microcapsules in samples 13A, 13B, and 13C are very similar.

EXAMPLE 6

This Example demonstrates another method for preparing spray dried spheroidal microcapsules and coated microcapsules according to the process of the present invention.

A spray dried spheroidal microcapsule or core particle was prepared having the composition set out in Table 15.

TABLE 15

SPRAY DRIED MICROCAPSULE COMPOSITION			
INGREDIENT	AMOUNT	% BY WEIGHT MICROCAPSULE	% BY WEIGHT AQUEOUS MIXTURE
Pseudoephedrine sulfate	480g	26.7	4.23%
Aluminum stearate	192g	10.68	1.69%
Ethyl Cellulose [46/72g of a 24% aqueous suspension of SURELEASE]	1120g	62.62	9.93%
1% Ammonium hydroxide	6000g		

The homogeneous mixture was spray dried in a Büchi 190 Mini Spray Dryer wherein the liquid feed rate was 15 ml/minute, the air flow rate was 600 Nl/h, the nozzle setting was 1.2 mm, the system pressure was from about 30 mm/Hg to about 50 mm/Hg, the air inlet temperature was about 114° C., and the air outlet temperature was from about 50° C. to about 67° C. A quantity of 1222g of the spray dried microcapsules containing pseudoephedrine sulfate were obtained which were passed through an 80 mesh screen (greater than 90% of the microcapsules passed through the screen).

A quantity of 800g of the spray dried microcapsule core material containing pseudoephedrine sulfate prepared above was spray coated with SURELEASE (24% aqueous suspension of ethyl cellulose with plasticizing agent diluted 1:1 with distilled water to prepare a 12% aqueous suspension) essentially according to the procedure set out in Example 1. The spray coating was carried out at a spray rate of 4.5 ml/min., a fluidizing air pressure of 20 psi, a nozzle setting of 1.0 mm, an air inlet temperature of about 40° C.-50° C., an air outlet temperature of about 28° C.-35° C., and a column height of 15 mm. Small agglomerates of film coated microcapsules were initially formed. Portions of these coated microcapsules were further coated with the aqueous film forming polymer suspension. The resulting coated microcapsules were dried in the fluidized bed for 20 minutes at 60° C. and cured at 60° C. for three hours. The compositions of the coated microcapsules with different levels of polymer coating are set out in Table 16 as samples 14-15.

TABLE 16

COATED MICROCAPSULES		
SAMPLE	PERCENTAGE POLYMER COATED	PERCENTAGE PSEUDOEPHEDRINE SULFATE
14	79.30	5.52
15	78.46	5.75

The film coated microcapsules of sample 15 were separated into particles having the particle size distribution set out in Table 17.

TABLE 17

PARTICLE SIZE DISTRIBUTION	
Mesh Size	15
	(Percentage of Particles)
40	5.75
60	63.26
80	20.64
100	5.94
140	3.88

Samples 14 and 15 were cured at 60° C. for three hours and in a separate run at 60° C. for three hours. The sustained release properties (dissolution) of each of the film coated microcapsules were measured by the rotating bottle method (The United States Pharmacopeia XXI) at 40 rpm at 37° C. in 80ml of distilled H₂O. The dissolution of the medicament from the coated microcapsules was measured by High Pressure Liquid Chromatography using an ultraviolet detector. The results of the dissolution study are set out in Table 18.

TABLE 18

DISSOLUTION STUDY				
Time (hours)	Cured at 60° C.		Cured at 80° C.	
	14	15	14	15
	(% Dissolution by Weight)			
0.5	23.91	22.59	22.65	21.77
1	36.10	32.57	42.55	40.53
2	55.12	47.40	59.13	60.67
4	64.99	60.79	65.37	71.93
6	71.65	68.78	70.71	77.03
8	75.03	73.47	72.63	78.89
24	78.73	80.74	77.74	82.60

Table 18 shows that the sustained release properties of the coated microcapsules in samples 14 and 15 when cured at 60° C. and 80° C. have similar properties.

The following samples of cured compositions were prepared:

TABLE 19

CURED SAMPLES	
SAMPLE	COMPOSITIONS
16	Sample 14 cured at 80° C. for 3 hours, particles in the 40-60 mesh range
17	Sample 14 cured at 80° C. for 3 hours, all particles
18	Sample 14 cured at 60° C. for 3 hours, all particles
19	Sample 15 cured at 80° C. for 3 hours, particles in the 40-60 mesh range
20	Sample 16 cured at 80° C. for 3 hours, all particles
21	Sample 17 cured at 60° C. for 3 hours, all particles

The sustained release properties (dissolution) of the film coated microcapsules of samples 16-21 was measured by the paddle method (The United States Pharmacopeia XXI) at 100 rpm at 37° C. in 900ml of distilled H₂O. The dissolution of the medicament from the coated microcapsules was measured by High Pressure Liquid Chromatography using an ultraviolet detector. The results of the dissolution study are set out in Table 20.

TABLE 20

DISSOLUTION STUDY						
TIME (hours)	16	17	18	19	20	21
	(% Dissolution by Weight)					
1	29.27	35.01	29.38	24.45	30.13	28.73
2	47.12	53.48	46.16	45.75	50.30	40.28
4	58.32	65.18	58.73	61.62	64.04	55.30
6	63.23	69.49	63.14	67.03	69.67	59.44
8	67.88	72.42	66.42	73.73	72.16	64.50
12	70.41	76.32	70.26	78.19	75.45	68.69
16	70.53	78.03	71.91	80.19	77.70	69.06

Table 20 shows that the sustained release properties of the coated microcapsules in the samples above when cured at 60° C. and 80° C. have similar properties.

- 6 The sustained release properties (dissolution) of the film coated microcapsules of sample 20 was measured by the basket method (The United States Pharmacopoeia XXI) at 100 rpm at 370 in 900ml of distilled H₂O. The dissolution of the medicament from the coated microcapsules was measured by High Pressure Liquid Chromatography using an ultraviolet detector. The results of the dissolution study are set out in Table 21.

TABLE 21

DISSOLUTION STUDY	
Time (hours)	20(± Dissolution by Weight)
1	19.61
2	33.26
4	48.63
6	56.10
8	60.10
12	64.35
16	67.32

- 25 Table 21 shows the sustained release properties of sample 20 by the basket method.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention and all such modifications are intended to be included within the scope of the following claims.

Claims

1. A spray dried spheroidal microcapsule under about 150 microns in diameter, which comprises:
 - 35 (a) a medicament in an amount of from about 1% to about 90% by weight of the microcapsule;
 - (b) a film forming polymer in an amount of from about 8% to about 90% by weight of the microcapsule; and
 - (c) a plasticizing agent in an amount of from about 5% to about 30% by weight of the film forming polymer.
2. A microcapsule according to claim 1, wherein the medicament is present in an amount of from about 1% to about 68% or 70% by weight of the microcapsule.
3. A microcapsule according to claim 1 or 2, wherein the film forming polymer is present in an amount from of about 20% to about 90% by weight of the microcapsule.
4. A microcapsule according to any of claims 1 to 3, wherein the plasticizing agent is present in an amount of from about 5% to about 24% by weight of the film forming polymer.
5. A microcapsule according to any of claims 1 to 4, wherein the medicament is a water-soluble medicament selected from dextromethorphan, dextromethorphan hydrobromide, pseudoephedrine, pseudoephedrine sulfate, pseudoephedrine hydrochloride, pseudoephedrine hydrobromide, chlorpheniramine maleate, guaifenesin, diphenhydramine hydrochloride, and mixtures thereof.
- 50 6. A microcapsule according to claim 5, wherein the medicament is selected from pseudoephedrine sulfate, diphenhydramine hydrochloride, chlorpheniramine maleate, and mixtures thereof.
7. A microcapsule according to any of claims 1 to 6, wherein the film forming polymer is a cellulose derivative selected from ethylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxypropylmethylcellulose phthalate, methylcellulose, sodium carboxymethylcellulose, and mixtures thereof.
8. A microcapsule according to claim 7, wherein the film forming polymer is ethyl cellulose.
9. A microcapsule according to any of claims 1 to 8, wherein the plasticizing agent is selected from acetyltributylcitrate, dibutyl sebacate, and mixtures thereof.
10. A microcapsule according to any of claims 1 to 9, further comprising a dispersing agent present in an

amount of up to about 12% by weight of the microcapsule.

11. A microcapsule according to claim 10, wherein the dispersing agent is selected from aluminium stearate, kaolin, fumed silica, and mixtures thereof.
12. A microcapsule according to any of claims 1 to 11, being under about 100 microns in diameter.
13. A spheroidal coated microcapsule under about 850 microns in diameter, which comprises at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, wherein the core is a spray dried spheroidal microcapsule according to any of claims 1 to 12, and wherein the coating layer over the core comprises:
 - (a) a film forming polymer; and
 - (b) a plasticizing agent in an amount of from about 5% to about 30% by weight of the film forming polymer of the coating layer.
14. A coated microcapsule according to claim 13, wherein the film forming polymer in the coating layer is a cellulose derivative selected from ethylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxypropylmethylcellulose phthalate, methylcellulose, sodium carboxymethylcellulose, and mixtures thereof.
15. A coated microcapsule according to claim 13 or 14, wherein the weight ratio of microcapsule core to coating layer is from about 1:9 to about 9:1.
16. A coated microcapsule according to any of claims 13 to 15, being under about 600 microns in diameter.
17. A method for preparing spray dried spheroidal microcapsules under about 150 microns in diameter, which comprises the steps of:
 - (A) providing the following ingredients:
 - (a) a medicament in an amount of from about 1% to about 90% by weight of the microcapsule;
 - (b) a film forming polymer in an amount of from about 8% to about 90% by weight of the microcapsule; and
 - (c) a plasticizing agent in an amount of from about 5% to about 30% by weight of the film forming polymer;
 - (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration of from about 0.25% to about 50%, and the film forming polymer is present in a concentration of from about 5% to about 40%, each by weight of the aqueous mixture; and
 - (C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under conditions such that spheroidal microcapsules under about 150 microns in diameter are formed.
18. A method according to claim 17, being subject to the limitations of one or more of claims 2 to 12.
19. A method according to claim 17 or 18, wherein the medicament in the aqueous mixture of step (B) is present in a concentration of from about 1% to about 35% by weight of the aqueous mixture.
20. A method according to any of claims 17 to 19, wherein the film forming polymer in the aqueous mixture of step (B) is present in a concentration of from about 10% to about 35% by weight of the aqueous mixture.
21. A method according to any of claims 17 to 20, wherein the conditions in the spray drying step of step (C) include a liquid feed rate of from about 5 ml/min. to about 25 ml/min.
22. A method according to any of claims 17 to 21, wherein the conditions in the spray drying step of step (C) include an air flow rate of from about 300 Nl/h to about 750 Nl/h.
23. A method according to any of claims 17 to 22, wherein the conditions in the spray drying step of step (C) include a nozzle setting of from about 0.8 mm to about 2mm.
24. A method according to any of claims 17 to 23, wherein the conditions in the spray drying step of step (C) include a system pressure of from about 25 mm/Hg to about 50 mm/Hg.
25. A method according to any of claims 17 to 24, wherein the conditions in the spray drying step of step (C) include an air inlet temperature of from about 60 °C to about 145 °C.
26. A method according to any of claims 17 to 25, wherein the conditions in the spray drying step of step (C) include an air outlet temperature of from about 40 °C to about 90 °C.
27. A method for preparing spheroidal coated microcapsules under about 850 microns in diameter which comprise at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, which comprises the steps of:
 - (A) forming spheroidal microcapsules by a method according to any of claims 17 to 26;
 - (B) providing the following ingredients of the coating layer:
 - (a) a film forming polymer; and
 - (b) a plasticizing agent in an amount of from about 5% to about 30% by weight of the film forming polymer;
 - (C) preparing an aqueous homogeneous mixture of the ingredients in step (B), wherein the film forming polymer is present in a concentration of from about 5% to about 40% by weight of the aqueous mixture;

- and
(F) coating the spray dried microcapsules from step (A) with the coating layer mixture from step (C) in a fluid bed dryer by suspending the microcapsules in a stream of air passing through a zone of the coating layer mixture under conditions such that spheroidal coated microcapsules under about 850 microns in diameter are formed.
28. A method according to claim 27, wherein the film forming polymer in the aqueous mixture of step (C) is present in a concentration of from about 5% to about 30% by weight of the aqueous mixture.
29. A method according to claim 27 or 28, wherein the conditions in the coating step of step (D) include a coating spray rate of from about 2 ml/min. to about 10 ml/min.
30. A method according to any of claims 27 to 29, wherein the conditions in the coating step of step (D) include a fluidizing air pressure of from about 1 atmosphere to about 5 atmospheres.
31. A method according to any of claims 27 to 30, wherein the conditions in the coating step of step (D) include a nozzle setting of from about 0.8 mm to about 2 mm.
32. A method according to any of claims 27 to 31, wherein the conditions in the coating step of step (D) include an outlet temperature of from about 20 °C to about 50 °C.
33. A method according to any of claims 27 to 32, wherein the spheroidal coated microcapsules are under about 600 microns in diameter.
34. A method according to any of claims 27 to 33, wherein the weight ratio of microcapsule core to coating layer is from about 1:9 to about 9:1.
35. A chewable medicated composition, which comprises a pharmaceutically acceptable carrier and a therapeutically effective amount of spray dried spheroidal microcapsules according to any of claims 1 to 12.
36. A medicated composition according to claim 35, wherein the microcapsules are present in an amount of from about 5% to about 50% by weight of the medicated composition.
37. A medicated composition according to claim 35 or 36, wherein the pharmaceutically acceptable carrier is selected from a lozenge, a tablet, a toffee, a nougat, a suspension, and a chewy candy.
38. A chewable sustained release medicated composition, which comprises a pharmaceutically acceptable carrier and a therapeutically effective amount of spheroidal coated microcapsules according to any of claims 13 to 16.
39. A sustained release medicated composition according to claim 38, wherein the coated microcapsules are present in an amount from about 5% to about 50% by weight of the medicated composition.
40. A sustained release medicated composition according to claim 38 or 39, wherein the pharmaceutically acceptable carrier is selected from a lozenge, a tablet, a toffee, a nougat, a suspension, and a chewy candy.
- 35 Claims for the following Contracting States: GR, ES
1. A method for preparing spray dried spheroidal microcapsules under about 150 microns in diameter, which comprises the steps of:
- (A) providing the following ingredients:
- (a) a medicament in an amount of from about 1% to about 90% by weight of the microcapsule;
- (b) a film forming polymer in an amount of from about 8% to about 90% by weight of the microcapsule; and
- (c) a plasticizing agent in an amount of from about 5% to about 30% by weight of the film forming polymer;
- (B) preparing an aqueous homogeneous mixture of the ingredients in step (A), wherein the medicament is present in a concentration of from about 0.25% to about 50%, and the film forming polymer is present in a concentration of from about 5% to about 40%, each by weight of the aqueous mixture; and
- (C) feeding the mixture of step (B) into a spray dryer and spray drying the mixture under conditions such that spheroidal microcapsules under about 150 microns in diameter are formed.
2. A method according to claim 1, wherein the medicament is present in an amount of from about 1% to about 68% or 70% by weight of the microcapsule.
3. A method according to claim 1 or 2, wherein the film forming polymer is present in an amount from about 20% to about 90% by weight of the microcapsule.
4. A method according to any of claims 1 to 3, wherein the plasticizing agent is present in an amount of from about 5% to about 24% by weight of the film forming polymer.
5. A method according to any of claims 1 to 4, wherein the medicament is a water-soluble medicament selected from dextromethorphan, dextromethorphan hydrobromide, pseudoephedrine, pseudoephedrine sulfate, pseudoephedrine hydrochloride, pseudoephedrine hydrobromide, chlorpheniramine maleate,

guaifenesin, diphenhydramine hydrochloride, and mixtures thereof.

6. A method according to claim 5, wherein the medicament is selected from pseudoephedrine sulfate, diphenhydramine hydrochloride, chlorpheniramine maleate, and mixtures thereof.
7. A method according to any of claims 1 to 6, wherein the film forming polymer is a cellulose derivative selected from ethylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxypropylmethylcellulose phthalate, methylcellulose, sodium carboxymethylcellulose, and mixtures thereof.
8. A method according to claim 7, wherein the film forming polymer is ethyl cellulose.
9. A method according to any of claims 1 to 8, wherein the plasticizing agent is selected from acetyltributylcitrate, dibutyl sebacate, and mixtures thereof.
10. A method according to any of claims 1 to 9, wherein the ingredients further comprise a dispersing agent present in an amount of up to about 12% by weight of the microcapsule.
11. A method according to claim 10, wherein the dispersing agent is selected from aluminium stearate, kaolin, fumed silica, and mixtures thereof.
12. A method according to any of claims 1 to 11, wherein the microcapsules formed are under about 100 microns in diameter.
13. A method according to any of claims 1 to 12, wherein the medicament in the aqueous mixture of step (B) is present in a concentration of from about 1% to about 35% by weight of the aqueous mixture.
14. A method according to any of claims 1 to 13, wherein the film forming polymer in the aqueous mixture of step (B) is present in a concentration of from about 10% to about 35% by weight of the aqueous mixture.
15. A method according to any of claims 1 to 14, wherein the conditions in the spray drying step of step (C) include a liquid feed rate of from about 5 ml/min. to about 25 ml/min.
16. A method according to any of claims 1 to 15, wherein the conditions in the spray drying step of step (C) include an air flow rate of from about 300 Nl/h to about 750 Nl/h.
17. A method according to any of claims 1 to 16, wherein the conditions in the spray drying step of step (C) include a nozzle setting of from about 0.8 mm to about 2mm.
18. A method according to any of claims 1 to 18, wherein the conditions in the spray drying step of step (C) include a system pressure of from about 25 mm/Hg to about 50 mm/Hg.
19. A method according to any of claims 1 to 18, wherein the conditions in the spray drying step of step (C) include an air inlet temperature of from about 80 °C to about 145 °C.
20. A method according to any of claims 1 to 19, wherein the conditions in the spray drying step of step (C) include an air outlet temperature of from about 40 °C to about 90 °C.
21. A method for preparing spheroidal coated microcapsules under about 850 microns in diameter which comprise at least one spray dried spheroidal microcapsule core under about 150 microns in diameter and a coating layer over the core, which comprises the steps of:
 - (A) forming spheroidal microcapsules by a method according to any of claims 1 to 20;
 - (B) providing the following ingredients of the coating layer:
 - (a) a film forming polymer; and
 - (b) a plasticizing agent in an amount of from about 5% to about 30% by weight of the film forming polymer;
 - (C) preparing an aqueous homogeneous mixture of the ingredients in step (B), wherein the film forming polymer is present in a concentration of from about 5% to about 40% by weight of the aqueous mixture; and
 - (F) coating the spray dried microcapsules from step (A) with the coating layer mixture from step (C) in a fluid bed dryer by suspending the microcapsules in a stream of air passing through a zone of the coating layer mixture under conditions such that spheroidal coated microcapsules under about 850 microns in diameter are formed.
22. A method according to claim 21, wherein the film forming polymer in the coating layer is a cellulose derivative selected from ethylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxypropylmethylcellulose phthalate, methylcellulose, sodium carboxymethylcellulose, and mixtures thereof.
23. A method according to claim 21 or 22, wherein the weight ratio of microcapsule core to coating layer is from about 1:9 to about 9:1.
24. A method according to any of claims 21 to 23, wherein the microcapsules formed are under about 800 microns in diameter.
25. A method according to any of claims 21 to 24, wherein the film forming polymer in the aqueous mixture of step (C) is present in a concentration of from about 5% to about 30% by weight of the aqueous mixture.
26. A method according to any of claims 21 to 25, wherein the conditions in the coating step of step (D) include a coating spray rate of from about 2 ml/min. to about 10 ml/min.
27. A method according to any of claims 21 to 26, wherein the conditions in the coating step of step (D)

include a fluidizing air pressure of from about 1 atmosphere to about 5 atmospheres.

28. A method according to any of claims 21 to 27, wherein the conditions in the coating step of step (D) include a nozzle setting of from about 0.8 to about 2 mm.

29. A method according to any of claims 21 to 28, wherein the conditions in the coating step of step (D) include an outlet temperature of from about 20 °C to about 50 °C.

30. A method according to any of claims 21 to 29, wherein the spheroidal coated microcapsules are under about 600 microns in diameter.

31. A method according to any of claims 21 to 30, wherein the weight ratio of microcapsule core to coating layer is from about 1:9 to about 9:1.

32. A process for preparing a chewable medicated composition, which comprises mixing a pharmaceutically acceptable carrier and a therapeutically effective amount of spray dried spheroidal microcapsules prepared by a method according to any of claims 1 to 20.

33. A process according to claim 32, wherein the microcapsules are used in an amount of from about 5% to about 50% by weight of the medicated composition.

34. A process according to claim 32 or 33, wherein the pharmaceutically acceptable carrier is selected from a lozenge, a tablet, a toffee, a nougat, a suspension, and a chewy candy.

35. A process for preparing a chewable sustained release medicated composition, which comprises mixing a pharmaceutically acceptable carrier and a therapeutically effective amount of spheroidal coated microcapsules prepared by a method according to any of claims 21 to 31.

36. A process according to claim 35, wherein the coated microcapsules are used in an amount from about 5% to about 50% by weight of the medicated composition.

37. A process according to claim 35 or 36, wherein the pharmaceutically acceptable carrier is selected from a lozenge, a tablet, a toffee, a nougat, a suspension, and a chewy candy.

FIG.1

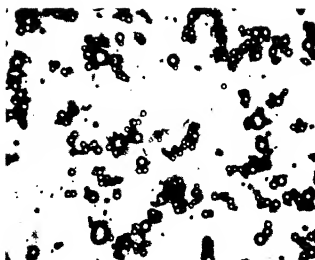


FIG.2

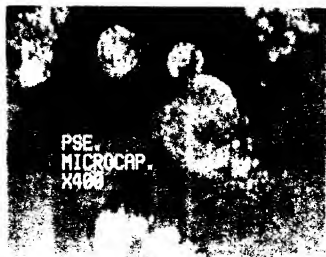
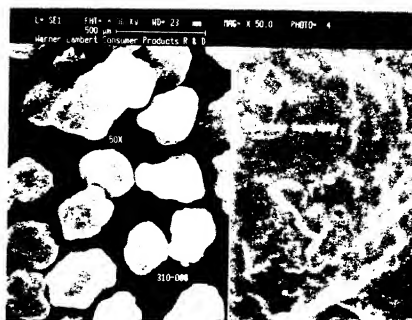


FIG.3





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 90308399.6

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 90308399.6
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US - A - 4 016 254 (H. SEAGER) * Column 3, line 36 - column 12, line 27 *	1, 2, 7, 8, 17, 18, 21-26, 35-37	A 61 K 9/50 A 61 K 9/52
X	US - A - 4 205 060 (H.G. MONSIMER et.al.) * Claims *	1, 5-7	
D, X	US - A - 4 749 575 (A. ROTMAN) * Column 3, line 41 - column 7, line 3 *	1, 35-37	
D, X	EP - A2/A3 - 0 265 226 (AMERICAN HOME PRODUCTS CORP.) * Totality *	1-3, 7, 8, 10-12, 35-37	
A	WO - A1 - 88/03 795 (A.M. MEHTA) * Claims; page 3, lines 14-27; page 16, line 34 - page 19, line 1; page 9, line 34 - page 10, line 10 *	1, 4-10, 13, 35-39	
A	US - A - 4 568 560 (A.M. SCHOBEL) * Totality *	1-12, 35-37	
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
VIENNA		18-12-1990	IRMLER
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : technological background O : non-written disclosure P : intermediate document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		A : member of the same patent family, corresponding document	